

# EPA Staff Paper on Gasoline Sulfur Issues

EPA Workshop on Gasoline Sulfur  
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Quality Hotel  
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# Overview of May 1, 1998 Paper

- Summarizes sulfur's impact on vehicle emissions from various technologies
- Discusses options for controlling sulfur
  - refining technology
  - costs
  - program design issues
- Cites other fuel issues which may impact gasoline sulfur control



# The Sulfur Effect

- Inhibits reactions on the catalytic surface
- Interferes with the management of oxygen on the catalyst surface
- Function of many factors, including:
  - design of the catalyst
  - range of exhaust temperatures
  - range of air-fuel mixtures



# Impact on Vehicle Emissions

Technology	NMHC <u>150 ppm</u>	330 ppm	NO <sub>x</sub> <u>150 ppm</u>	330 ppm
Tier 0 LDV/LDT	5.9%	16.3%	6.4%	13.8%
Tier 1 LDV	---	20.9%	---	13.6%
LEV/ULEV LDVs	23.0%	26.4%	33.7%	65.5%
LEV/ULEV LDVs	26.7%	43.0%	65.7%	136%
9 Lowest Emitters	26.8%	44.0%	127%	264%
9 Least Sensitive	32.2%	49.5%	31.0%	61.0%

LEV/ULEV LDVs = LDT2, LDT3

LEV/ULEV LDVs = LDV + LDT1



# Mitigating the Sulfur Effect

- Reduce the sulfur sensitivity to that of the nine least sensitive LEVs & ULEVs
- Use rhodium - least sensitive PGM metal
- Maintain consistently high temps during typical operation
- Increase the total precious metal content



# Impact Cannot be Eliminated

- Limitations to what can be accomplished through chemistry
- Off-cycle standards place additional limits on the fuel management strategy and catalyst designs
- Future Tier 2 vehicles may have to meet more stringent emission standards than LEVs



# Reversibility

- Limited data from manufacturers vary
  - some models easily reversed
  - others require extreme conditions
- EPA continuing to evaluate
- CRC test program soon to be completed
- Significant factor in deciding about national, year-round program



# Advanced Technologies

- May be even more sensitive to sulfur
  - Current designs can tolerate very little gasoline sulfur
  - However, some designs appear reasonably sulfur tolerant
- Catalyst experts indicate sulfur may always be a design limitation



# Certification Fuel v. In-Use Fuel

- Two possible ways to reconcile
- Increase the sulfur content of test fuel
  - increases the stringency of Tier 2 standards, or
  - results in numerically higher standards
- Reduce the sulfur in commercial gasoline
  - opposite effect
  - also reduces emissions from the current fleet
  - may enable advanced technologies



# Sulfur Control at the Refinery

- Sulfur levels outside of CA average over 300 ppm
- Sulfur in gasoline varies due to
  - specific crude oil processed
  - the processing capability of the refinery
- Most likely technique: desulfurize the FCC gasoline
- Other options are available



# Sulfur Control Cost Estimates

- Preliminary, based on current refining technologies, assuming 8% ROI for capital

Sulfur Control Level (ppm, on average)	EPA/DOE <u>PADDS 1 &amp; 3</u>	API/MathPro <u>PADDS 1, 2, &amp; 3</u>
150	1.1-1.8 c/gal	2.65 c/gal
100	1.9-3.0	3.4
40	5.1-8.0	5.1

- New technologies may lower cost to <2.0 c/gal for control to 40 ppm



# Sulfur Program Options

- Refinery average v. per-gallon maximum
  - Sulfur sensitivity
  - Enforcement complexities
- Annual v. seasonal
  - Air quality/other environmental benefits
  - Reversibility
- National v. regional control area
  - Reversibility
  - Other benefits (PM, toxics, etc.)



# Other Fuel Issues

- Gasoline distillation properties
  - Currently evaluating emissions impact
  - Some connection to sulfur control possible
- Diesel fuel sulfur, other properties
  - Need for control will be reviewed (1999, 2001 heavy-duty engine technical reviews)
  - Concurrent diesel sulfur and gasoline sulfur control has potential synergies



# Staff Paper Conclusions

- Sulfur levels in commercial gasoline must be reduced
- Certification test fuel and commercial fuel sulfur levels must be reconciled
- EPA will proceed with development of proposed rule
- Other fuel issues will be considered as more data become available



# Outstanding Issues

- Need more data on reversibility
- Additional information on advanced refining technologies, including costs
- Better understanding of the interaction between sulfur and advanced technology vehicle designs

